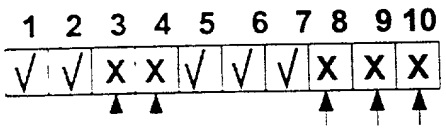
Figure 1



√ = Packets received

X = Packets NOT received

Figure 2A
Application Send Thread

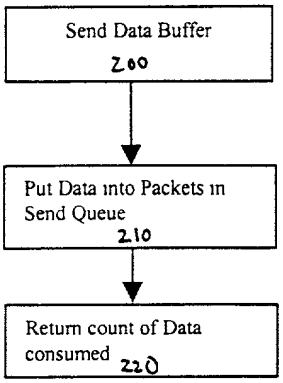


Figure 2B
ATP Send Thread

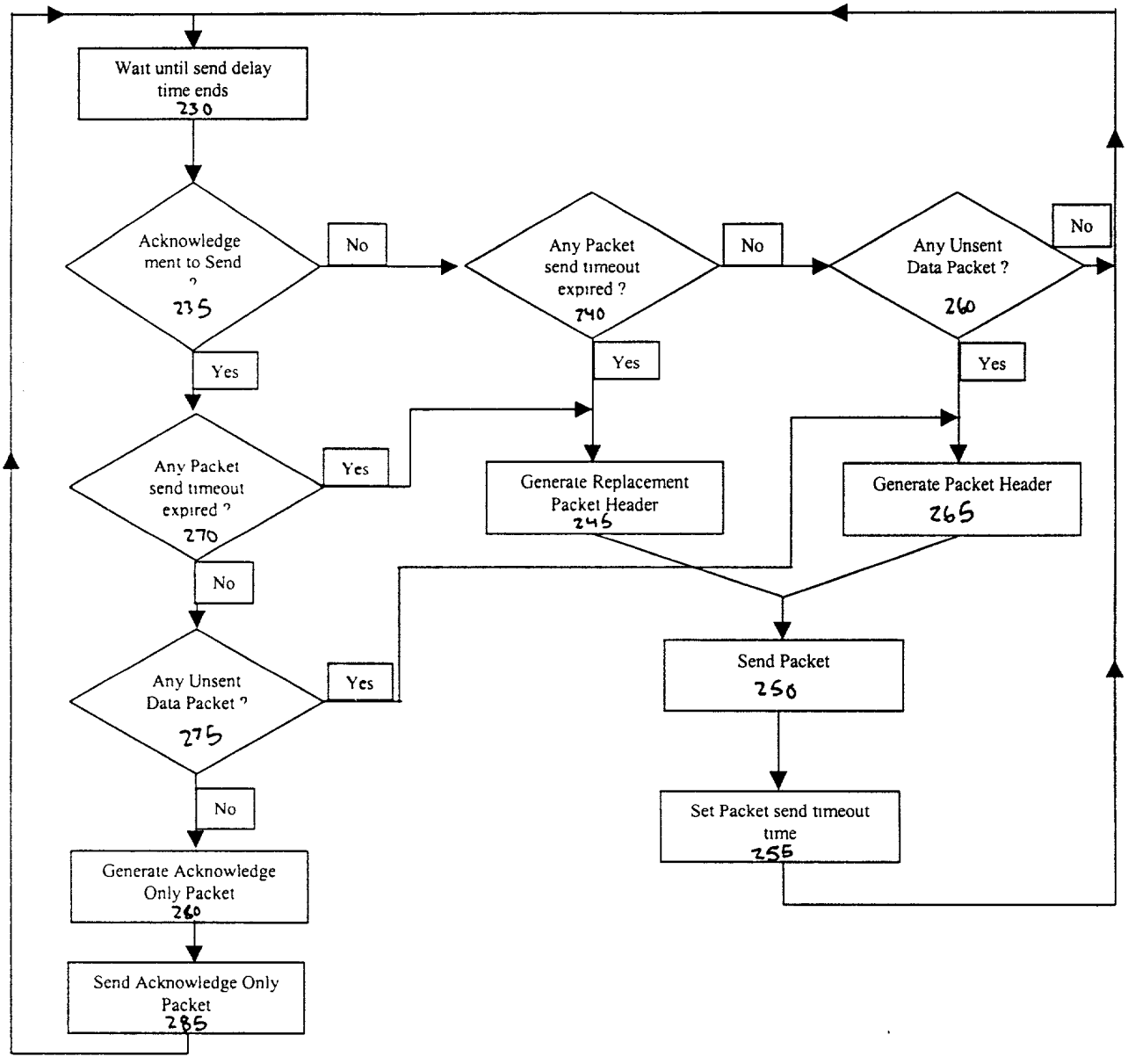
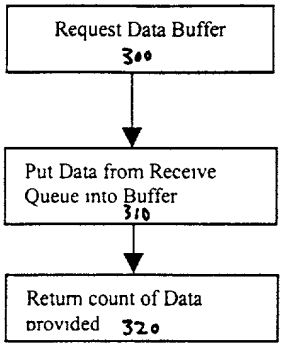
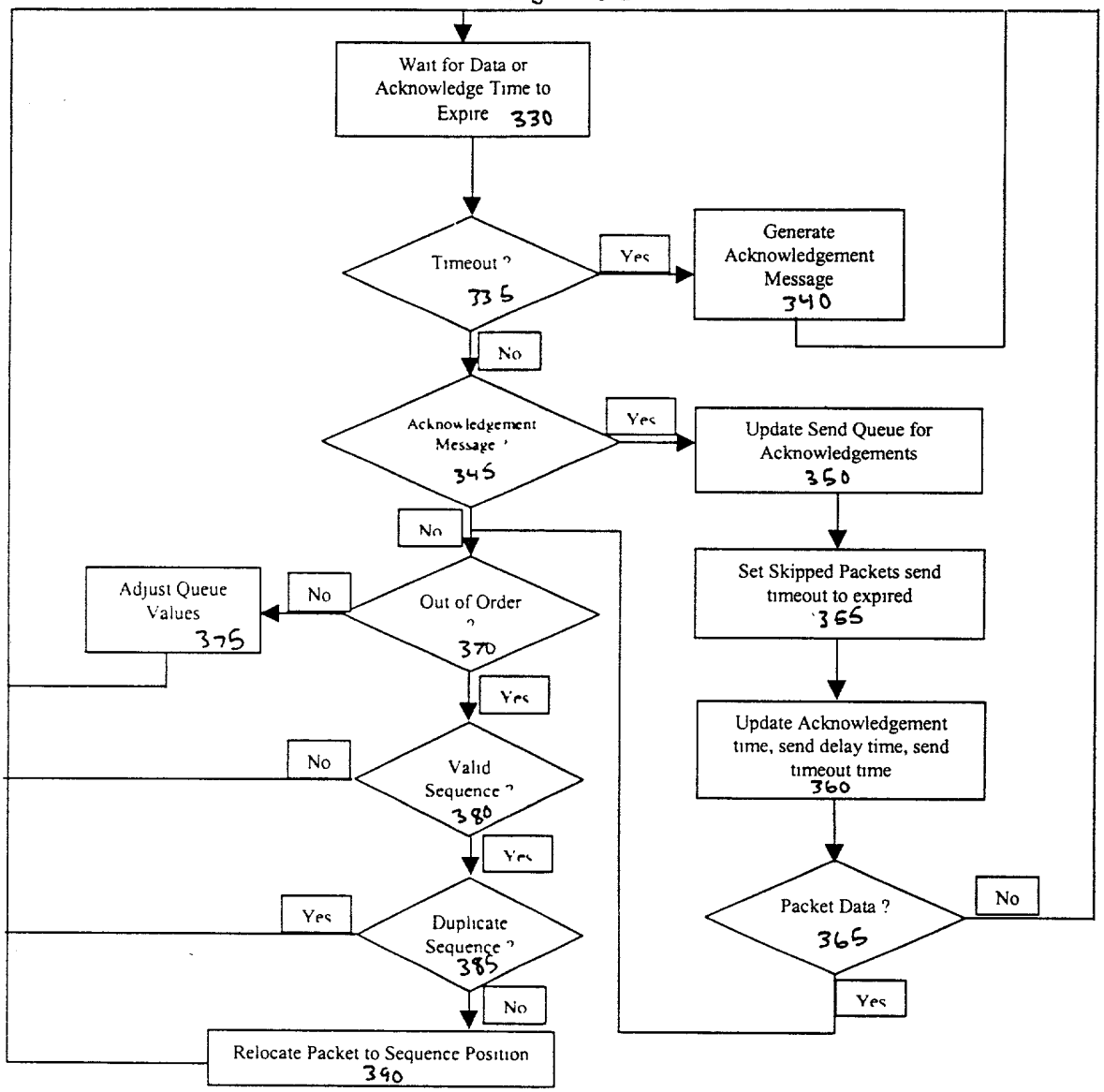


Figure 3A
Application Receive Thread



ATP Receive Thread
Figure 3B



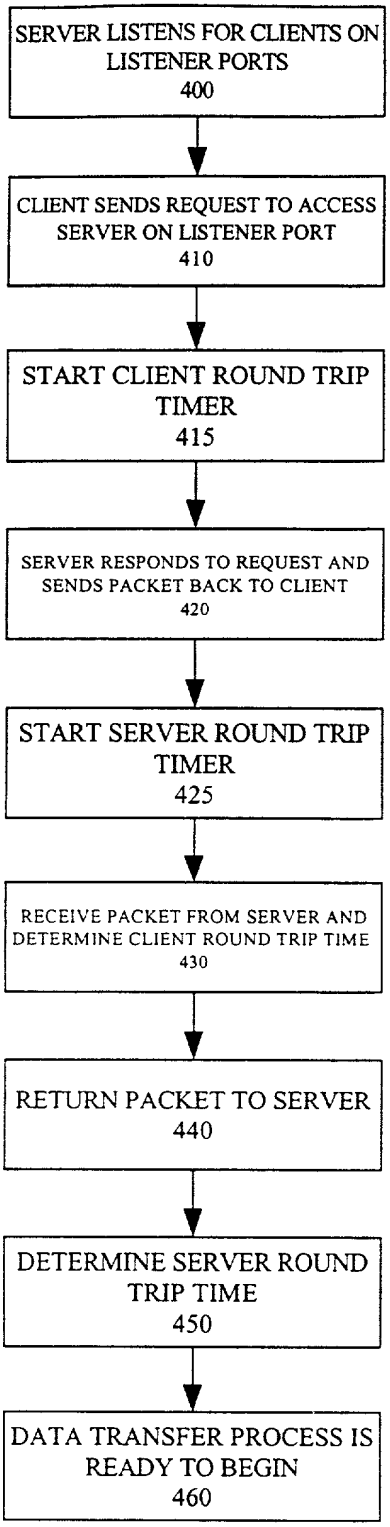

SERVER LISTENS FOR CLIENTS ON LISTENER PORTS
400
CLIENT SENDS REQUEST TO ACCESS SERVER ON LISTENER PORT
410
START CLIENT ROUND TRIP TIMER
415
SERVER RESPONDS TO REQUEST AND SENDS PACKET BACK TO CLIENT
420
START SERVER ROUND TRIP TIMER
425
RECEIVE PACKET FROM SERVER AND DETERMINE CLIENT ROUND TRIP TIME
430
RETURN PACKET TO SERVER
440
DETERMINE SERVER ROUND TRIP TIME
450
DATA TRANSFER PROCESS IS READY TO BEGIN
460

FIGURE 4

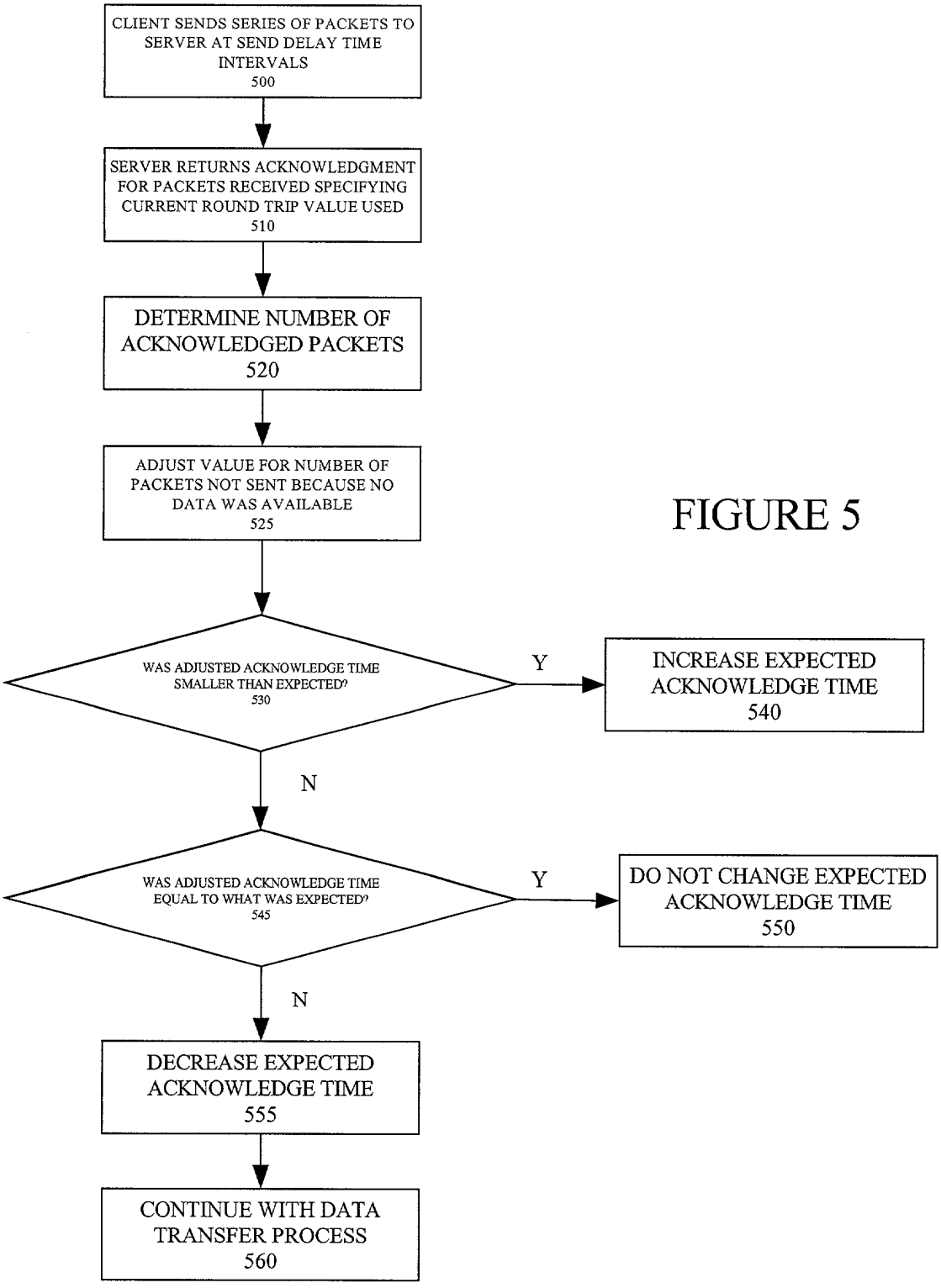

CLIENT SENDS SERIES OF PACKETS TO SERVER AT SEND DELAY TIME INTERVALS
500
SERVER RETURNS ACKNOWLEDGMENT FOR PACKETS RECEIVED SPECIFYING CURRENT ROUND TRIP VALUE USED
510
DETERMINE NUMBER OF ACKNOWLEDGED PACKETS
520
ADJUST VALUE FOR NUMBER OF PACKETS NOT SENT BECAUSE NO DATA WAS AVAILABLE
525
WAS ADJUSTED ACKNOWLEDGE TIME SMALLER THAN EXPECTED?
530
Y
INCREASE EXPECTED ACKNOWLEDGE TIME
540
N
WAS ADJUSTED ACKNOWLEDGE TIME EQUAL TO WHAT WAS EXPECTED?
545
Y
DO NOT CHANGE EXPECTED ACKNOWLEDGE TIME
550
N
DECREASE EXPECTED ACKNOWLEDGE TIME
555
CONTINUE WITH DATA TRANSFER PROCESS
560

FIGURE 5

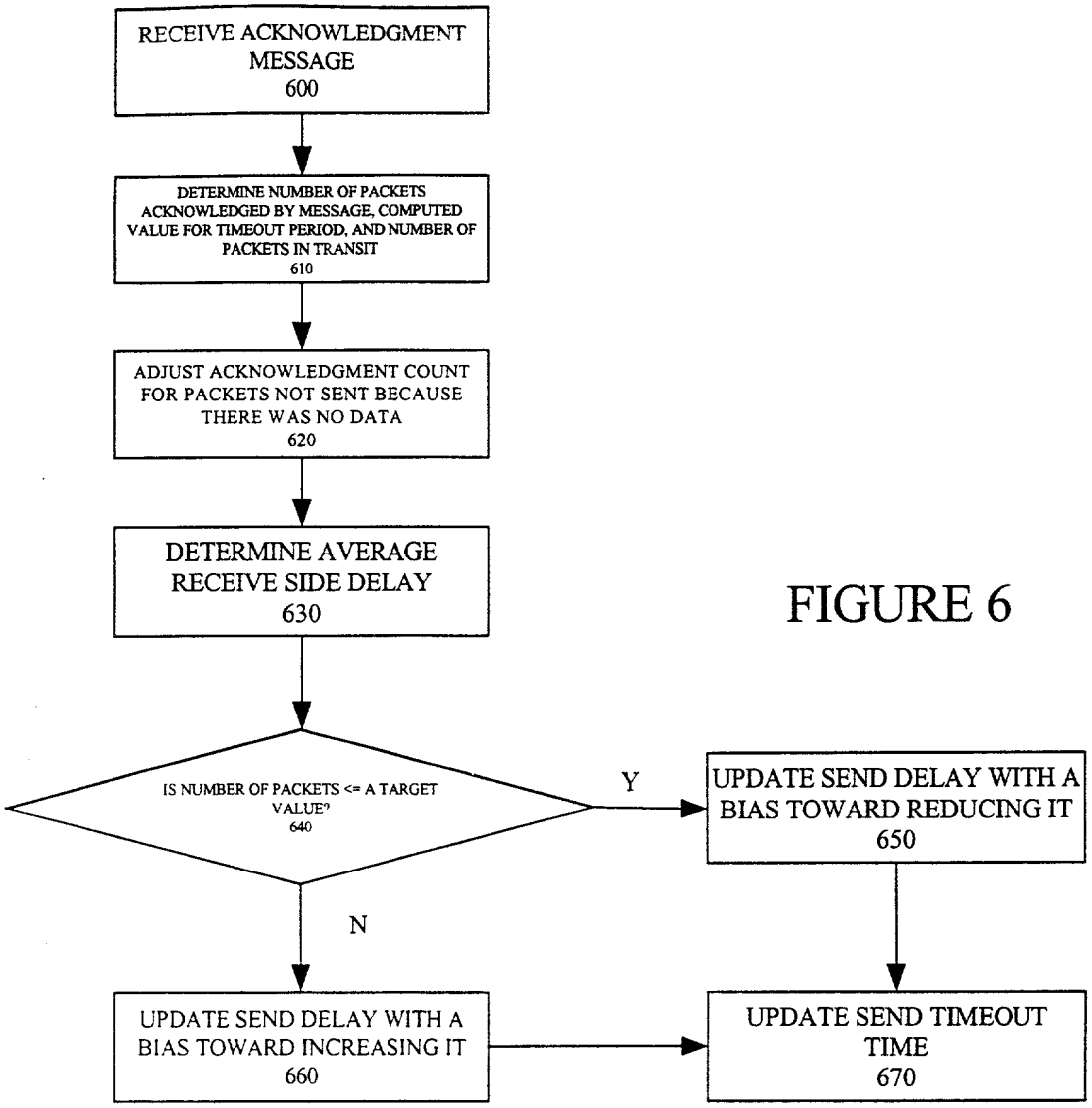

RECEIVE ACKNOWLEDGMENT MESSAGE
600
DETERMINE NUMBER OF PACKETS ACKNOWLEDGED BY MESSAGE, COMPUTED VALUE FOR TIMEOUT PERIOD, AND NUMBER OF PACKETS IN TRANSIT
610
ADJUST ACKNOWLEDGMENT COUNT FOR PACKETS NOT SENT BECAUSE THERE WAS NO DATA
620
DETERMINE AVERAGE RECEIVE SIDE DELAY
630
IS NUMBER OF PACKETS <= A TARGET VALUE?
640
Y
UPDATE SEND DELAY WITH A BIAS TOWARD REDUCING IT
650
N
UPDATE SEND DELAY WITH A BIAS TOWARD INCREASING IT
660
UPDATE SEND TIMEOUT TIME
670

FIGURE 6

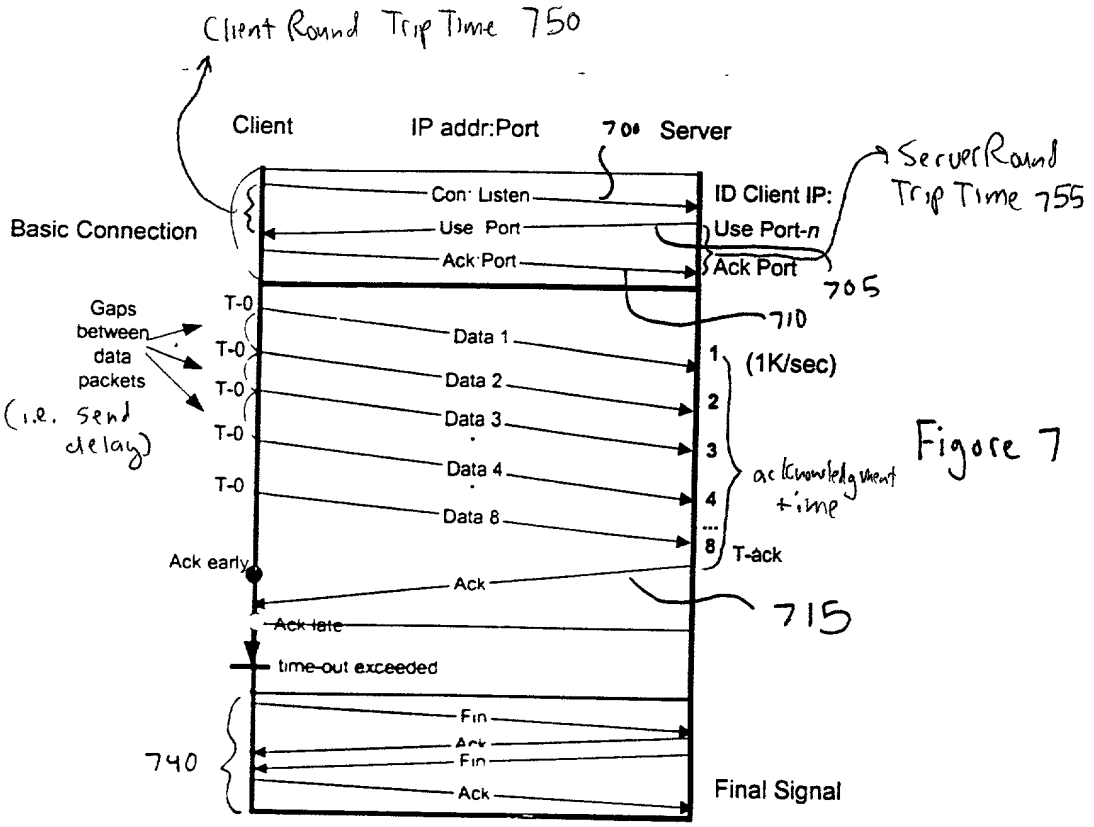

Client Round Trip Time 750
Client
IP addr:Port
700 Server
Server Round Trip Time 755
Basic Connection
Con. Listen
Use Port
Ack Port
ID Client IP:
Use Port-n
Ack Port
705
710
Gaps between data packets
(i.e. send delay)
T-0
Data 1
Data 2
Data 3
Data 4
Data 8
1
2
3
4
8
(1K/sec)
acknowledgment time
T-ack
Ack early
Ack
715
Ack late
time-out exceeded
740
Fin
Ack
Fin
Ack
Final Signal

Figure 7

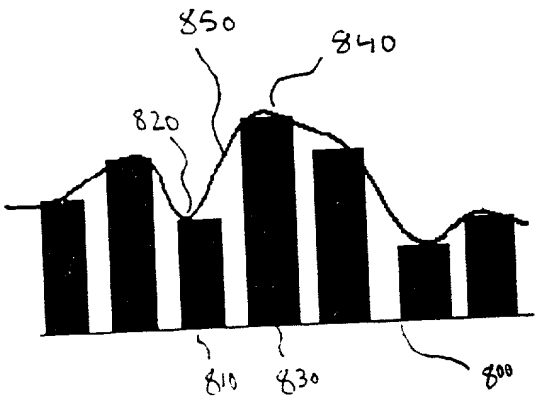


Figure 8

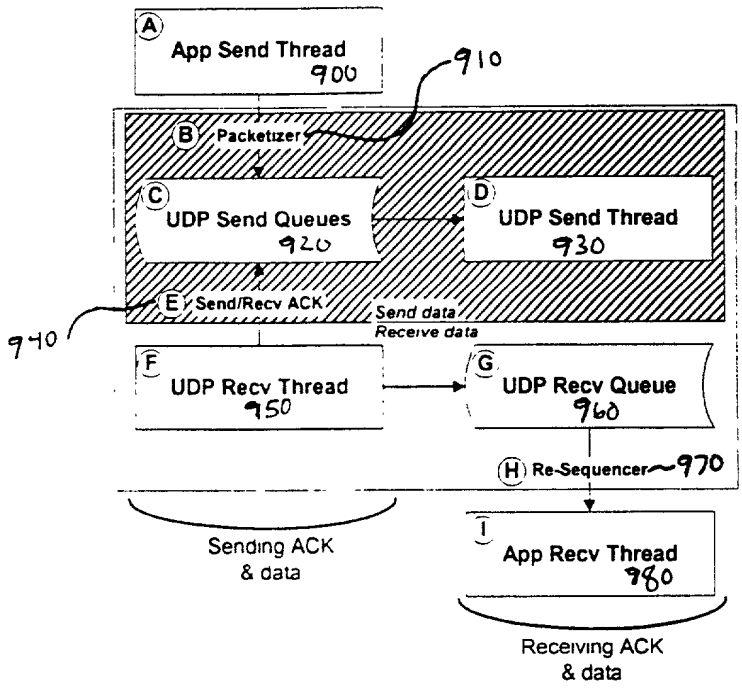


Figure 9

Figure 10

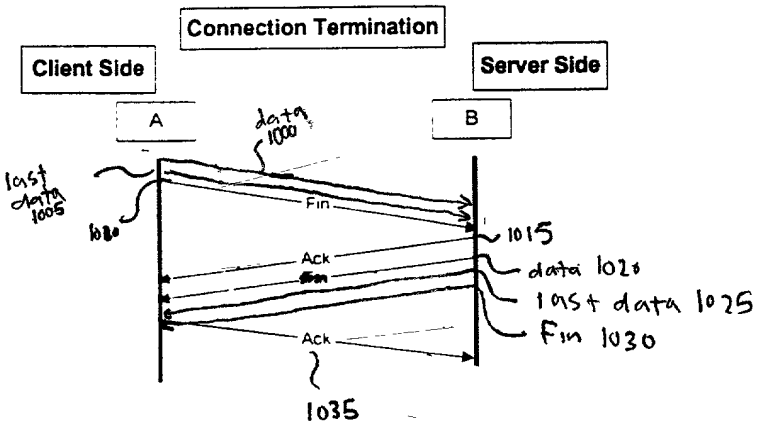
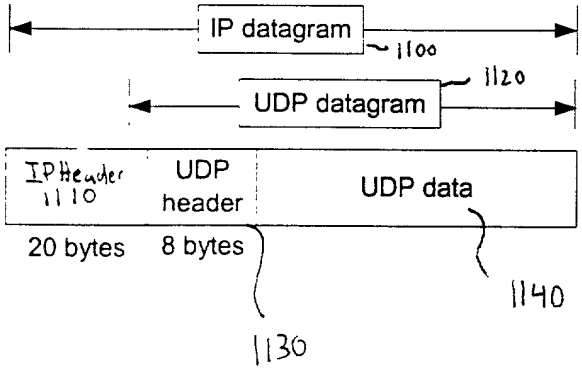

Connection Termination
Client Side
Server Side
A
B
data 1000
last data 1005
1010
Fin
1015
Ack
data 1020
last data 1025
Fin 1030
Ack
1035

Figure 11


IP datagram
1100
1120
UDP datagram
IP Header
1110
UDP
header
UDP data
20 bytes
8 bytes
1130
1140

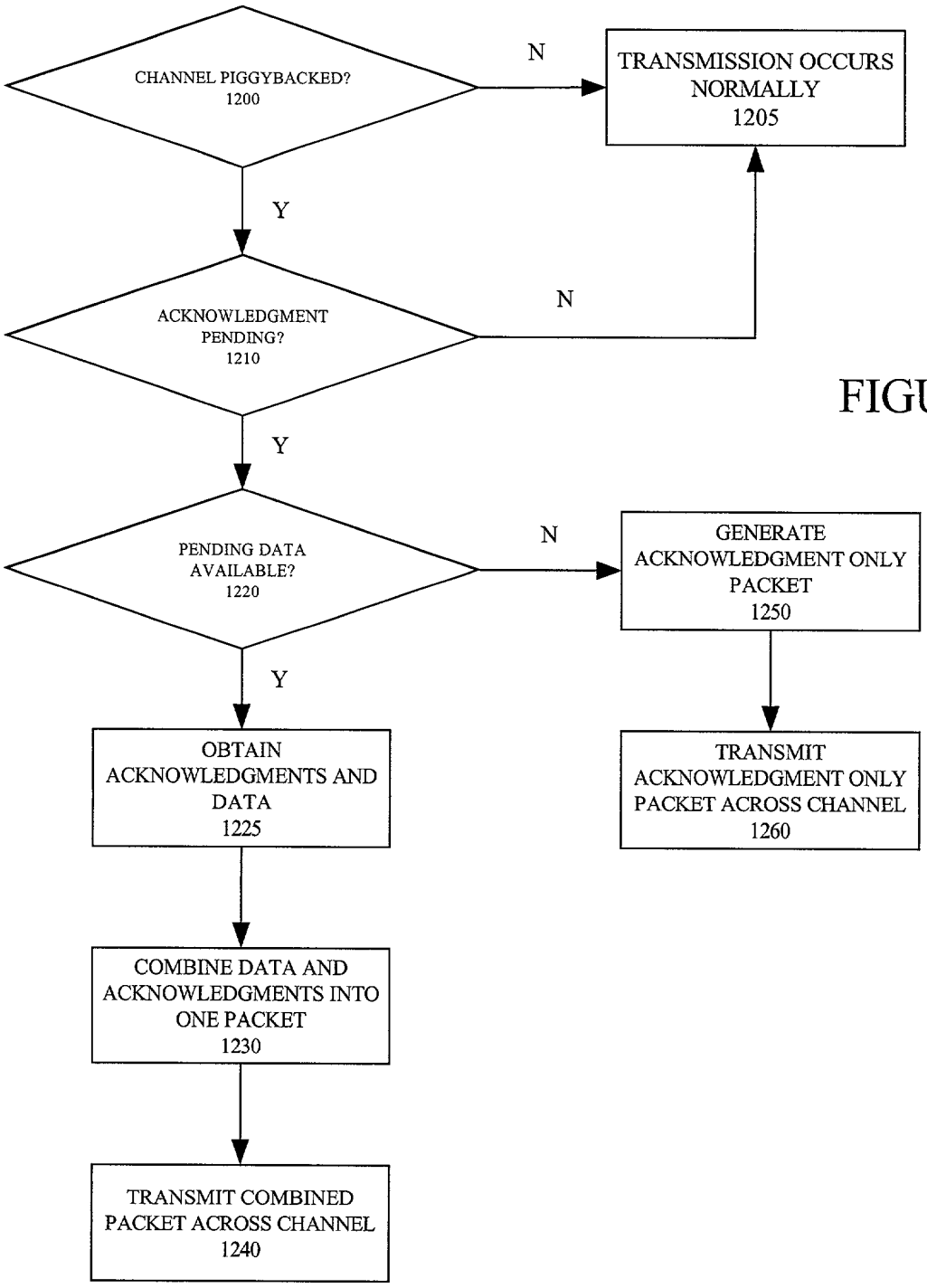

CHANNEL PIGGYBACKED?
1200
N
TRANSMISSION OCCURS NORMALLY
1205
Y
ACKNOWLEDGMENT PENDING?
1210
N
Y
PENDING DATA AVAILABLE?
1220
N
GENERATE ACKNOWLEDGMENT ONLY PACKET
1250
Y
OBTAIN ACKNOWLEDGMENTS AND DATA
1225
TRANSMIT ACKNOWLEDGMENT ONLY PACKET ACROSS CHANNEL
1260
COMBINE DATA AND ACKNOWLEDGMENTS INTO ONE PACKET
1230
TRANSMIT COMBINED PACKET ACROSS CHANNEL
1240

FIGURE 12

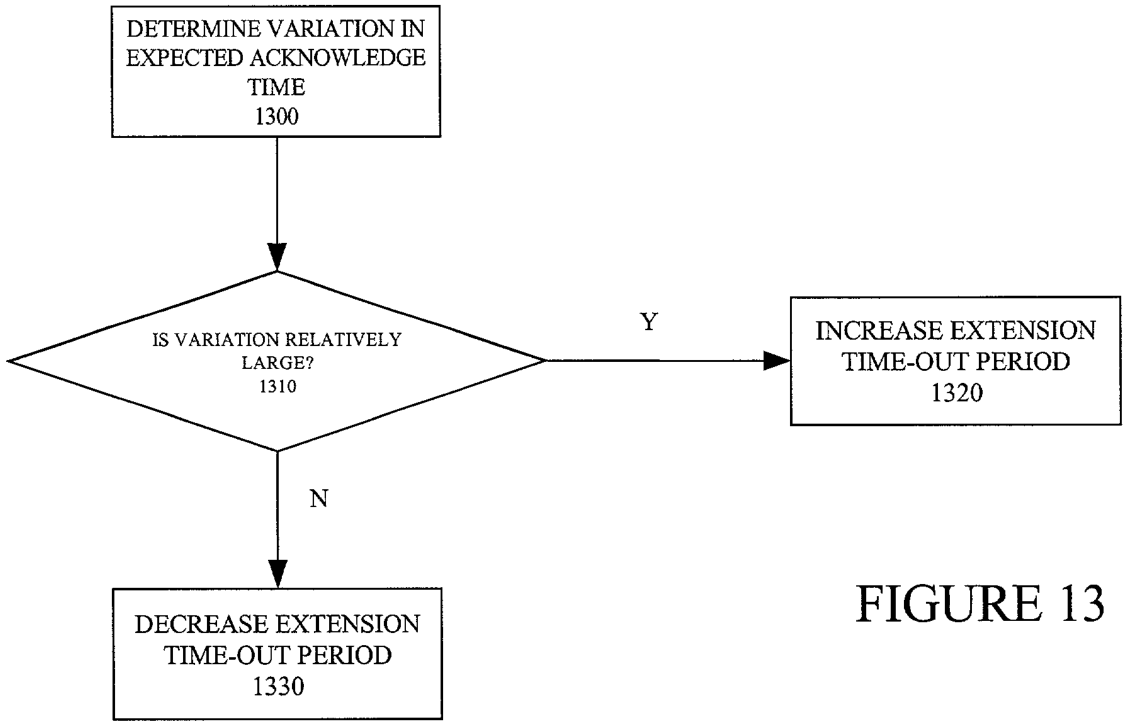

DETERMINE VARIATION IN EXPECTED ACKNOWLEDGE TIME 1300
IS VARIATION RELATIVELY LARGE? 1310
Y
INCREASE EXTENSION TIME-OUT PERIOD 1320
N
DECREASE EXTENSION TIME-OUT PERIOD 1330

FIGURE 13

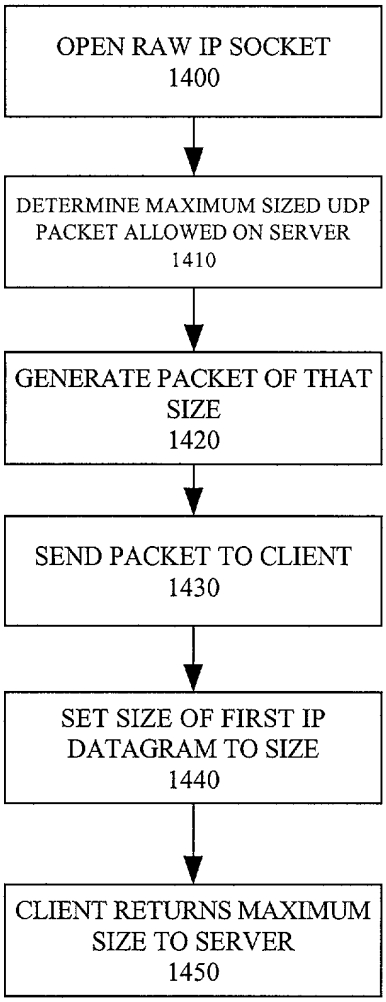

OPEN RAW IP SOCKET
1400
DETERMINE MAXIMUM SIZED UDP PACKET ALLOWED ON SERVER
1410
GENERATE PACKET OF THAT SIZE
1420
SEND PACKET TO CLIENT
1430
SET SIZE OF FIRST IP DATAGRAM TO SIZE
1440
CLIENT RETURNS MAXIMUM SIZE TO SERVER
1450

FIGURE 14

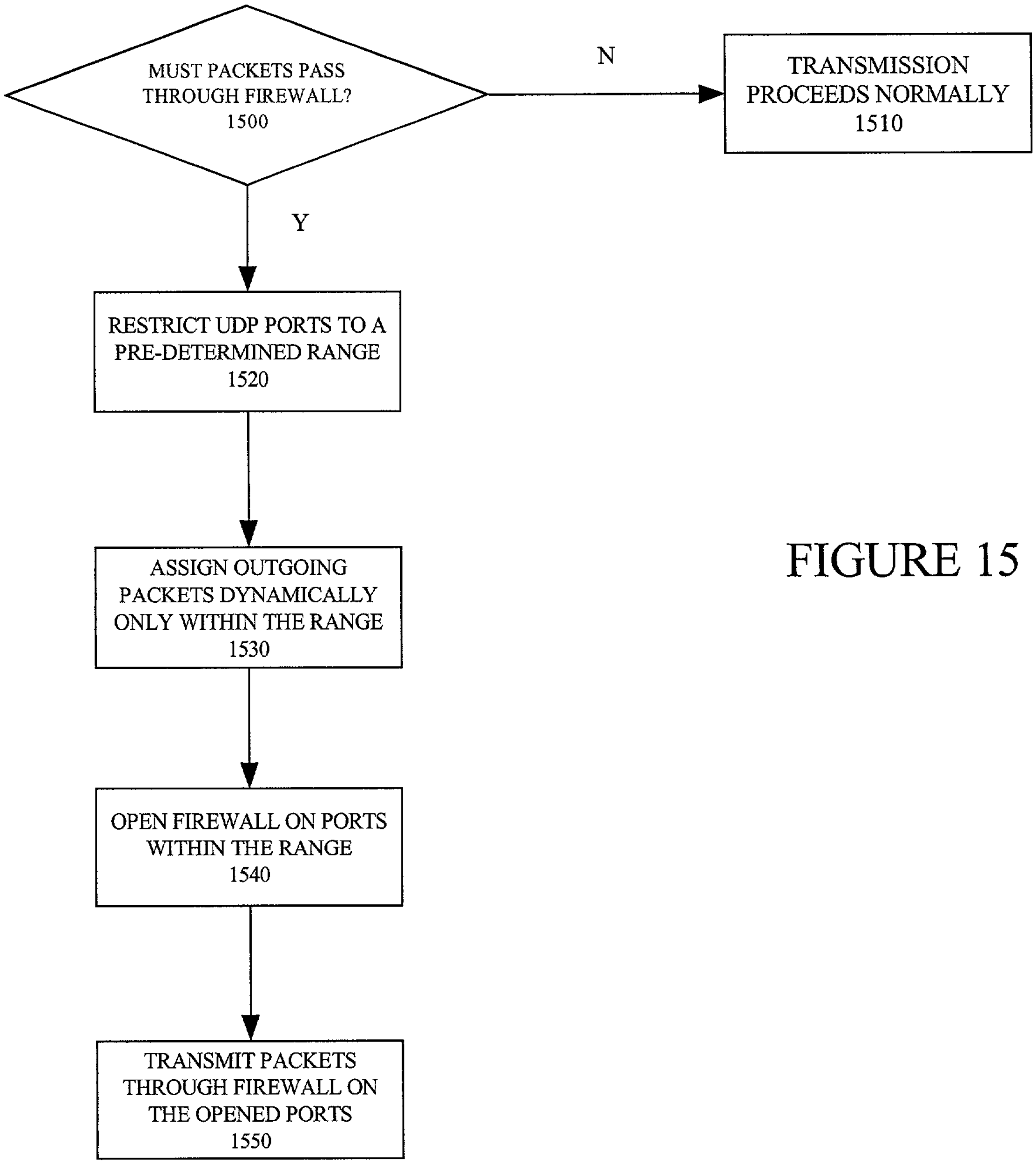

MUST PACKETS PASS THROUGH FIREWALL? 1500
N
TRANSMISSION PROCEEDS NORMALLY 1510
Y
RESTRICT UDP PORTS TO A PRE-DETERMINED RANGE 1520
ASSIGN OUTGOING PACKETS DYNAMICALLY ONLY WITHIN THE RANGE 1530
OPEN FIREWALL ON PORTS WITHIN THE RANGE 1540
TRANSMIT PACKETS THROUGH FIREWALL ON THE OPENED PORTS 1550

FIGURE 15

<table>
<tr><td>Version</td><td>IHL</td><td>TOS</td><td colspan="2">Length</td></tr>
<tr><td colspan="3">Identification</td><td>Flags</td><td>Fragment Offset</td></tr>
<tr><td colspan="2">Time To Live</td><td>Protocol</td><td colspan="2">Checksum</td></tr>
<tr><td colspan="5">Source IP Address</td></tr>
<tr><td colspan="5">Destination IP Address</td></tr>
</table>

Figure 16

<table>
<tr><td colspan="3">Source Port</td><td colspan="2">Destination Port</td></tr>
<tr><td colspan="5">Sequence Number</td></tr>
<tr><td colspan="5">Acknowledgement Number</td></tr>
<tr><td>Offset</td><td>Reserve</td><td>Flags</td><td colspan="2">Window</td></tr>
<tr><td colspan="3">Checksum</td><td colspan="2">Urgent Pointer</td></tr>
<tr><td colspan="4">Options (if used)</td><td>Padding</td></tr>
</table>

Figure 17